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## SOLAR OBSERVATIONS

[Meteorological Research Division, EDGAR W. WOOLARD in charge]

### SOLAR RADIATION OBSERVATIONS, APRIL, 1939

By IRVING F. HAND

Measurements of solar radiant energy received at the surface of the earth are made at eight stations maintained by the Weather Bureau, and at nine cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at three Weather Bureau stations (Washington, D. C., Madison, Wis., Lincoln, Nebr.) and at the Blue Hill Observatory of Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau stations at Washington and Madison.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data, obtained up to the end of 1936, will be found in the *MONTHLY WEATHER REVIEW*, December 1937, pp. 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and

their departures from normal (means based on less than 3 values are in parenthesis). At Madison and Lincoln the observations are made with the Marvin pyrheliometer; at Washington and Blue Hill they are obtained with a recording thermopile, checked by observations with a Marvin pyrheliometer at Washington and with a Smithsonian silver disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 8 a. m. (75th meridian time) and at noon (local mean solar time).

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, their departures from normal, and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of the Eppley pyrheliometer recording on either a microammeter or a potentiometer.

Direct radiation intensities averaged above normal for April at all Weather Bureau stations.

Total solar and sky radiation was above normal at all stations with the exception of Madison, New York, La Jolla, Miami, Riverside, Ithaca, Newport, Fairbanks, and Blue Hill.

Polarization measurements made on 5 days at Madison give a mean of 55 percent with a maximum of 61 percent on the 30th. Both of these values are close to the corresponding normals for April.

TABLE 1.—*Solar radiation intensities during April 1939*

[Gram-calories per minute per square centimeter of normal surface]

## WASHINGTON, D. C.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass								Local mean solar time	
		A. M.				P. M.					e
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
April 4	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.	2.49
April 5	2.74	—	0.83	1.00	1.21	—	—	—	—	3.30	—
April 6	3.30	—	.93	1.05	1.26	1.49	—	—	—	2.82	—
April 7	2.74	—	—	1.00	1.16	1.39	—	—	—	7.57	—
April 10	5.56	—	—	—	—	.99	—	—	—	3.45	—
April 12	5.16	0.60	.78	.94	1.11	—	—	—	—	4.75	—
April 14	3.45	.68	.75	.81	1.01	—	—	—	—	3.81	—
April 20	4.95	.95	1.01	1.06	1.18	—	—	—	—	4.75	—
April 21	8.18	—	—	—	1.08	—	—	—	—	6.50	—
April 22	5.79	—	.87	.95	1.13	(1.44)	—	—	—	4.95	—
Means.	—	.74	.86	.97	1.13	(1.44)	—	—	—	—	—
Departures	+.04	+.07	+.08	+.05	+.07	—	—	—	—	—	—

## MADISON, WIS.

April 3	3.45	—	—	1.24	1.45	—	—	—	—	—	3.63
April 4	3.63	0.70	0.86	1.04	1.20	1.54	—	—	—	—	3.15
April 8	2.36	.88	1.08	1.15	—	—	—	—	—	—	3.00
April 12	1.88	—	1.16	1.26	1.40	—	—	—	—	—	1.88
April 13	2.26	—	.90	1.05	1.20	1.44	—	—	—	—	3.00
April 22	3.99	—	.94	1.07	1.22	1.42	—	—	—	—	4.57
April 29	5.38	—	—	1.17	1.39	1.53	—	—	—	—	3.30
Means.	(.79)	.95	1.14	1.31	1.48	—	—	—	—	—	—
Departures	-.03	+.01	+.09	+.10	+.04	—	—	—	—	—	—

## LINCOLN, NEBR.

April 6	2.36	—	—	—	1.45	—	—	—	—	—	1.60
April 7	2.74	—	—	—	1.29	1.60	—	—	—	—	2.74
April 8	3.15	—	0.88	1.08	1.29	1.61	—	—	—	—	3.00
April 11	4.95	—	—	—	—	1.30	1.12	0.95	0.85	—	1.32
April 12	2.26	0.72	.79	.92	1.34	—	—	—	—	—	1.96
April 13	4.37	—	.85	1.01	1.21	—	1.25	—	—	—	4.17
April 19	4.75	—	.97	1.13	1.35	1.55	1.31	1.09	.94	.78	3.81
April 21	5.36	—	.72	.89	1.14	—	—	—	—	—	6.76
April 25	8.18	—	.84	1.02	1.18	—	—	—	—	—	7.87
April 27	7.04	—	.90	1.06	1.21	1.44	1.17	.95	.76	.65	4.75
April 28	6.02	—	.81	.91	1.14	—	—	—	—	—	7.24
April 29	6.27	—	.79	1.16	—	—	—	—	—	—	6.50
Means.	(.72)	.83	.99	1.25	1.55	1.26	1.05	.88	.76	—	—
Departures	.00	.00	+.02	+.06	+.09	+.08	+.09	+.06	+.07	—	—

\*Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

[Gram-calories per square centimeter]

Week beginning—	Wash- ington	Mad- ison	Lin- coln	Chi- cago	New York	Fresno	Fair- banks	Twin Falls	La Jolla	Miami	New Orleans	River- side	Blue Hill	San Juan	Friday Harbor	Ithaca	New- port
	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
April 2	505	392	434	372	325	559	364	505	450	428	457	467	388	625	415	194	368
April 9	510	337	366	283	392	568	272	386	413	498	467	408	358	720	365	176	387
April 16	435	250	391	225	313	556	275	545	405	465	470	552	413	680	544	206	439
April 23	348	554	605	466	296	626	399	473	507	491	406	460	303	639	439	233	336

## DEPARTURES FROM WEEKLY NORMALS

April 2	+138	+22	+25	+82	+6	+40	+27	+68	-52	-33	+77	-25	-28	+32	+87	-44	-24
April 9	+133	-65	-76	+61	+65	-5	-91	-72	-59	+25	+64	-71	+13	+92	+56	-77	-36
April 16	+13	-144	-60	-109	-51	-40	-99	+63	-68	-12	+49	+23	+18	+41	+108	-61	-4
April 23	-98	+121	+159	+99	-115	+50	-10	-29	-14	+11	+12	-23	-144	+17	-62	-161	-158

## ACCUMULATED DEPARTURES ON APRIL 29

	+3,115	+952	+532	+2,758	-504	-714	-1,379	-763	+1,400	+1,603	+5,355	-1,491	-1,393	+5,214	+2,898	-4,697	-1,960
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TABLE 1.—*Solar radiation intensities during April 1939—Continued*

[Gram-calories per minute per square centimeter of normal surface]

## BLUE HILL, MASS.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass								Local mean solar time	
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
April 3	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.	2.9
April 5	2.9	—	—	—	—	—	—	—	—	—	2.9
April 6	3.0	—	—	—	—	—	—	—	—	—	3.2
April 7	5.6	—	—	—	—	—	—	—	—	—	3.7
April 9	3.1	—	—	—	—	—	—	—	—	—	4.2
April 13	2.6	—	—	—	—	—	—	—	—	—	3.1
April 14	3.1	—	—	—	—	—	—	—	—	—	3.6
April 20	5.5	—	—	—	—	—	—	—	—	—	5.3
April 21	4.9	—	—	—	—	—	—	—	—	—	5.4
April 23	5.5	—	—	—	—	—	—	—	—	—	6.5
April 25	6.1	—	—	—	—	—	—	—	—	—	6.3
Means.	—	—	—	—	—	—	—	—	—	—	—
Departures	—	—	—	—	—	—	—	—	—	—	—

## LATE REPORT—DURING MARCH 1939

March 1	5.4	—	—	—	0.74	—	—	—	—	—	—	—	—	—	—	—	3.8
March 2	2.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.2
March 3	1.4	0.99	1.10	1.22	—	—	—	—	—	—	—	—	—	—	—	—	1.9
March 7	2.6	.88	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.5
March 8	1.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.9
March 10	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.4
March 12	2.2	.88	.96	1.14	—	—	—	—	—	—	—	—	—	—	—	—	2.2
March 17	1.9	.86	—	—	—	—											